The Underinvestment Problem and Corporate Derivatives Use

Gerald D. Gay and Jouahn Nam

Gerald D. Gay is Professor of Finance at Georgia State University. Jouahn Nam is Assistant Professor of Finance at Pace University.

We analyze the underinvestment problem as a determinant of corporate hedging policy. We find evidence of a positive relation between a firm's derivatives use and its growth opportunities, as proxied by several alternative measures. For firms with enhanced investment opportunities, derivatives use is greater when they also have relatively low cash stocks. Firms whose investment expenditures are positively correlated with internal cash flows tend to have smaller derivatives positions, which suggests potential natural hedges. Our findings support the argument that firms' derivatives use may partly be driven by the need to avoid potential underinvestment problems.

■ In a perfect world such as that of Modigliani and Miller (1958), there would almost be no justification for corporations to engage in hedging, including those strategies that use derivatives. However, financial economics offers several hypotheses to explain why corporate hedging can be rational or value-enhancing, each of which relies on some form of market imperfection. One hypothesis, based on the shareholder-value-maximization paradigm, suggests that hedging can increase firm value by reducing expected taxes, lowering the expected costs of financial distress, or alleviating the underinvestment problem associated with costly external financing. A second hypothesis is based on agency theory, and it focuses on the private motives of managers who attempt to maximize their personal wealth through risk management.

The primary focus of this paper is on one of the less well-explored hypotheses, alleviating the underinvestment problem through hedging. As described in Froot, Scharfstein, and Stein (1993), costly external financing is a market imperfection that makes hedging a value-enhancing strategy. That is, an underinvestment problem results when firms find that external financing is sufficiently expensive that they must reduce investment spending during times when internally generated cash flows are not sufficient to finance growth opportunities.[1] Hedging or risk management in this situation adds value because it helps ensure that the corporation has sufficient funds available to take advantage of attractive investment opportunities.

Our paper investigates these issues. Our analysis builds on existing empirical studies by using improved methods for capturing investment opportunities, and by examining interaction effects among a firm's investment opportunities, cash stocks, and internally generated funds. We are thus able to more clearly distinguish the role of the underinvestment hypothesis in the determination of corporate hedging policy.

Following standard convention, we assume for analytical purposes that firms conduct their hedging

We wish to thank the following individuals for their helpful comments and assistance: Michael Rebello, Tom Noe, Jayant Kale, Chris Bollinger, Steve Smith, John Thornton, S.G. Badrinath, session participants of the 1997 Annual Meeting of the International Association of Financial Engineers, the Editors, and two anonymous reviewers.

[1]Lewent and Kearney (1990) report that companies reduce their capital expenditures by roughly $0.35 for each dollar reduction in cash flow. Referring to the pharmaceutical industry, they state that "... our experience, and that of industry in general, has been that cash flow and earnings uncertainty caused by exchange-rate volatility leads to a reduction of growth in research spending."

through the use of derivatives. We recognize that in addition to using derivatives, firms can and do use other techniques to manage risk.

The paper is organized as follows. Section I reviews the extant literature that deals with the role of risk management in mitigating the underinvestment problem. Section II presents three testable hypotheses examining the importance of internally generated cash flow, cash stocks, and investment opportunities on a firm's hedging position. The empirical results are presented in Section III. Section IV concludes.

I. Prior Research: Underinvestment and the Use of Derivatives

Froot, Scharfstein, and Stein (1993) develop a general framework for analyzing corporate risk management in the presence of costly external financing. Their risk-management paradigm rests on three premises: first, firm value is created through investment in positive net-present-value (NPV) projects. Second, an important key for supporting good investments is internal generation of sufficient cash to fund those investments. When firms do not generate sufficient cash flow, they tend to cut investments below the optimal level because of costly external financing. Third, internally generated cash flow, which is critical to the investment process, can be disrupted by external factors such as movements in exchange rates, interest rates, or commodity prices. Under this framework, Froot et al. show that a firm's hedging activity can increase value to the extent that it ensures that a firm has sufficient cash flow available to make value-enhancing investments. Other studies, including Smith and Stulz (1985) and Smith, Smithson, and Wilford (1990), develop rationales for hedging similar to Froot et al. However, Tufano (1998) discusses the potential value-decreasing effects of cash flow hedging associated with heightened agency conflicts between managers and shareholders.

Empirical studies provide mixed support for the underinvestment hypothesis. Nance, Smith, and Smithson (1993), Geczy, Minton, and Schrand (1995), and Dolde (1995) find that firms with high levels of research and development (R&D) expenses are more likely to use some form of derivatives instrument. However, using a market-to-book-value ratio to proxy for a firm's future investment opportunities, Mian (1996) finds a negative relation between a firm's investment opportunities and its derivatives use, which does not support the underinvestment hypothesis. Mian states that one explanation for not finding a positive association between hedging and the market-to-book ratio could be due to constraints imposed by mandated reporting requirements on hedging of anticipated exposures. However, these reporting requirements do not predict a negative association. For a sample of New Zealand firms, Berkman and Bradbury (1996) find little or no support for the underinvestment hypothesis when using either an earnings-price ratio or asset growth/cash flow variable to capture a firm's investment opportunity set.

To empirically test the underinvestment-problem hypothesis in the Froot et al. (1993) framework, we must recognize two conditions to induce hedging activity. First, the firm must have access to positive NPV projects. Second, there must be a reasonable probability that the firm will have insufficient internally generated cash to fund these projects. Two possible sources of internally generated cash must be considered, cash on hand and cash flow from operations. We find that it is important to use accurate proxies for a firm's investment opportunities as well as available sources of generated cash.

First, most of the earlier studies of corporate derivatives use have used only a few proxies to capture a firm's investment opportunities, and these could contain substantial noise. The two most commonly used proxies have been a firm's market-to-book-value ratio (e.g., Nance, Smith, and Smithson, 1993; Li, 1996; and Mian, 1996) or its normalized R&D expenditures (e.g., Nance, Smith, and Smithson, 1993; Geczy, Minton, and Schrand, 1996; and Wysocki, 1996).

A rationale for using the market-to-book-value ratio is that it measures the likelihood that a firm will have positive-NPV projects or growth opportunities. This is based on the idea that market value represents both the values of a firm's assets in place and future growth opportunities. Book value captures the value of assets in place. Thus, the ratio provides a relative measure of a firm's growth opportunities.

As one alternative to the market-to-book-value ratio, financial economists often use Tobin's q as a measure of a firm's investment opportunities, where Tobin's q is the ratio of the market value of the firm to the replacement cost of its assets. However, earlier studies of derivatives use have not used Tobin's q as a measure.

Similarly, use of R&D costs as a growth proxy is justified on the basis that these expenses are predictors of the development of future projects. However, R&D, like other proxies, can also capture other unintended effects.

For example, Froot et al. (1993) point out that R&D outlays can also be viewed either as a measure of a firm's intangible assets or of asymmetric information about the quality of new projects. Froot et al. explain that it might be more difficult for R&D-intensive firms to raise external financing. This is because lenders do not view these firms' (principally intangible) assets as quality collateral (see Titman and Wessels, 1988), or because

there is likely to be greater asymmetric information about the quality of the new projects. Also, borrowing constraints that result from this asymmetric information might increase the probability of financial distress. Thus, in addition to capturing a firm's growth opportunities, R&D expenses could also be proxying for costly external financing or financial distress costs.

Alternatively, the relation between R&D expenses and derivatives use can be driven by agency problems. Good managers who have little incentive to hide their true quality will make the optimal level of investment. Since good managers know that they might be forced to reduce investment below the optimal level because of costly external financing, they are more likely to hedge market risks to ensure that the firm has sufficient funds for investment. Managers, usually the ones who are poor managers, could be motivated to hide their true quality by spending more capital on long-term projects such as R&D or by mimicking the hedging strategies of good managers.[2] That is, as poor managers spend more capital on R&D, they might engage in greater hedging activities, thus masking their managerial ability and the quality of their projects. In either well- or poorly managed firms, we can expect a positive association between the level of R&D and derivatives use. But, while R&D might be a proxy for investment opportunities of well-managed firms, for poorly managed firms it can capture the firm's agency problems.

Therefore, to gain a more robust insight into the relation between a firm's derivatives use and its growth opportunities, we should analyze the results from using several alternative proxies. The tests conducted below use five measures: R&D expenses, the market-to-book-value ratio, Tobin's q, price-earnings ratio, and cumulative abnormal returns (CAR). We describe the measurement of these variables in the next section.

A second way in which we extend prior studies is to consider the interaction between a firm's investment opportunities and its available cash stock. Nance, Smith, and Smithson (1993) and Geczy, Minton, and Schrand (1995) find that firms that engage in more R&D are more likely, and that firms with high levels of short-term liquidity are less likely, to use derivatives. The tests below support these findings by examining the interaction between a firm's cash stock and its investment opportunities. The tests specifically examine whether firms with greater investment opportunities but lower levels of cash have a greater incentive to hedge, since such firms are more likely to require costly external financing.

Third, in examining the underinvestment problem, we explore the importance of potential natural or operational hedges (see Tufano, 1996 and, Petersen and Thiagarajan, 1997).[3] We do this by studying the correlation between a firm's investment expenses and cash flow. We first consider a firm with a constant level of optimal investment (i.e., the optimal level of investment is invariant to the amount of internally generated funds). In this case, a greater level of sensitivity of a firm's investment expenses to its cash flows suggests that the firm suffers from an underinvestment problem and could benefit from hedging. However, this argument assumes that a firm's investment opportunities are nonstochastic, and thus independent of the cash flows generated from its assets in place.

However, in many cases, this assumption may not be accurate. When firms experience reduced cash flows, it is often due to conditions that affect the entire industry. These conditions might coincide with reduced investment opportunities available to the firm. If this is the case, then the firm has less incentive to hedge, since in periods with low cash flow, the firm will have access to fewer investment opportunities that require financing. Conversely, the firm will probably have greater investment opportunities at times when it is experiencing greater cash flows. Alternatively, some firms can structure operations so that their expenses are substantially lower when cash inflows are low, thus lowering their reliance on external financing (see Petersen and Thiagarajan, 1997). Thus, a firm's underinvestment problem is alleviated if the firm is naturally or operationally hedged. The tests in Section III examine whether firms with cash flows more closely correlated with investment expenditures engage in less hedging activity.

II. Empirical Framework

In this section, we present three hypotheses that are the focus of our empirical investigation. We then describe our sample, the various proxies used for capturing a firm's growth opportunities, and the control variables we use in the analysis.

A. Hypotheses

To examine the importance of internally generated cash flow, cash stocks, and investment opportunities on a firm's use of derivatives, we investigate three hypotheses suggested by the underinvestment theory.

[2]Ljungqvist (1994) shows that with unobservable risk-management activities, bad firms will speculate, so that if they get a lucky draw, they can be pooled with the good firms.

[3]Tufano (1996) offers the following example: a company engaged in gold mining may find that both its current cash flow and the marginal product of additional investments (i.e., expenditures on further exploration) decline when the price of gold falls. For such a company, hedging against declines in the price of gold is less valuable because the supply of funds is matched with the demand for funds, reducing the dependence on costly external financing.

Hypothesis 1: Firms with greater investment or growth opportunities will make greater use of derivatives.

Hypothesis 2: Firms with enhanced investment opportunities concurrent with low levels of cash stocks will make greater use of derivatives than similar firms with high cash stocks.

Hypothesis 3: Firms with greater correlation between cash flows and investment expenses will use derivatives less.

B. Sample Description

We conduct our analysis on a sample of derivatives-using and non-using corporations. We construct our sample both by combining all corporations in the 1996 Swaps Monitor database published by Swaps Monitor Publications, Inc. and the listing of *Business Week 1000* firms. The Swaps Monitor database provides information on the notional amount of interest-rate and currency derivatives, including swaps, forwards, options, and futures, held by firms as of their 1995 fiscal year-end. For commodity derivatives, the database gives the contract quantity from which we calculate notional dollar amounts by multiplying quantities by fiscal year-end commodity prices.

Our analysis focuses on non-financial corporations because of their less frequent use of derivatives for trading purposes or in the course of performing dealer activities. To be included in the analysis, we require firms to have filed a proxy statement for 1995 and to be in the Compustat database for all years between 1993 and 1995. We exclude private companies, subsidiaries of foreign-owned corporations, firms acquired during fiscal year 1995, and firms categorized as derivatives users but with missing notional-values information. After eliminating firms that are missing one or more explanatory variables (discussed below), we have a common sample of 325 users and 161 non-users of derivatives. We use this sample of firms for testing both the first and second hypotheses.

Tables 1 and 2 provide descriptive information for the 325 user firms. Panel A of Table 1 describes the number of firms according to their use of interest-rate, currency, or commodity derivatives. As expected, interest-rate and currency derivatives use is significantly greater than that of commodity derivatives.

Panel B, Table 1, shows derivatives use by instrument type. For users of interest-rate derivatives, swaps are the primary instrument of choice, followed by options and finishing with futures and forward contracts. However, for managing currency risk, futures and forwards are the primary instruments of choice.

For commodity derivatives, instrument choice is more evenly distributed. These observations are consistent with recent Wharton/CIBC Wood Gundy survey results for non-financial US corporations (see Bodnar, Hayt, and Marston, 1996, and Smithson, 1997) and with survey results for a sample of New Zealand firms reported in Berkman, Bradbury, and Magan (1997).

Table 2 examines the sample by industry according to two-digit SIC classification. The sample represents 26 different industries. Chemicals and allied products, computer and office equipment, and electronics and electrical equipment are the most heavily represented industries.

To test the third hypothesis, we construct a sample of user firms that we restrict to firms that use only interest-rate derivatives. This restriction ensures a more accurate examination of the impact on the hedging decision of the correlation between internally generated cash flows (pre-risk-management cash flows) and investment expenses. Under current hedge accounting rules, gains or losses from hedging activities are recorded in the consolidated statements of income as adjustments to revenue or the cost of the underlying physical transaction. However, for most firms, hedging gains or losses are not specifically identified as such. Instead, they are embedded in conventional measures of a firm's cash flow based on net profit or earnings before interest and taxes (EBIT), and cannot be separated because of disclosure limitations. Tufano (1996) has also noted this problem.

For example, for currency and commodity derivatives, the risk that is being hedged is typically associated with operations, so the gains or losses on these derivatives are reflected in EBIT. But it is not possible in most cases to adjust this EBIT cash flow to a pre-risk-management basis by adding (subtracting) back in derivatives losses (gains), since this information is not separately reported. In contrast, the risk hedged by interest-rate derivatives is associated with interest expense.[4] Fortunately, interest expense and its adjustments are reported "below" EBIT. Thus, EBIT provides a clean measure of pre-risk-management cash flow for interest-rate derivatives users.

To calculate the correlations (CORR) used in testing the third hypothesis, we required a minimum of 12, and up to 20, yearly observations for both a firm's investment expenditures and cash flows. That is, to be included in the analysis, a firm should have data in the

[4]To illustrate, Wells Fargo & Co. defers and amortizes gains and losses on interest-rate futures as a component of its interest income or expenses on the asset or liability hedged. Gibson Greetings an accounting item called "interest income (gain) loss on derivative transaction/settlement, net" to recognize the gains or losses from its interest-rate derivatives use.

Table 1. Descriptive Information for 1995 Derivative Users Sample

This table provides information on the type and amount of derivatives used by a sample of 325 derivatives-using firms observed at year-end 1995.

Panel A. Number of Users and Notional Amounts (Millions of Dollars) by Product Type

Product Type	Number of Users	Notional Amount: Mean (Median)
Interest-Rate Derivatives	214	296.8 (100.8)
Currency Derivatives	173	365.7 (63.5)
Commodity Derivatives	72	64.3 (15.3)

Panel B. Number of Users and Notional Amounts (Millions of Dollars) by Instrument Type

Instrument Type	Swaps	Forwards/Futures	Options
Interest-Rate Derivatives:			
Number of Users	158	26	71
Notional Amount:			
Mean	320.80	207.81	170.96
Median	105.00	125.00	78.05
Currency Derivatives:			
Number of Users	49	138	45
Notional Amount:			
Mean	390.13	348.90	360.05
Median	135.00	48.00	98.50
Commodity Derivatives:			
Number of Users	35	28	21
Notional Amount:			
Mean	73.45	62.27	57.80
Median	58.50	42.00	38.50

Compustat database for all years 1984 to 1995, and possibly back to 1976, depending on data availability. Again, we excluded private companies, subsidiaries of foreign-owned corporations, firms acquired during fiscal year 1995, and firms categorized as derivatives users but lacking information on their notional values. This resulted in a sample of 137 interest-rate-derivatives only users. In addition, we developed a matching sample of 137 nonfinancial firms that did not use any derivatives in 1995. For the matching criterion to create comparable levels of interest-rate-risk exposure, we selected the total debt of the firm as of year-end 1994. We required that firms in the matching sample have the requisite investment expense and cash flow data on Compustat for at least each of the years from 1984 through 1995.

C. Description of Key Variables

We next describe the dependent variables, growth variables, and dummy variable we use in the analysis.

1. Dependent Variables

In addition to a univariate analysis in which we compare users and non-users of key variables of interest, we use alternative Tobit model specifications for a portion of our multivariate analysis. We do this to accommodate the left-truncated nature of the dependent variables as can be seen by the following. We use "Y*" as the dependent variable in the Tobit model specification for testing the first two hypotheses. We define Y* as the notional dollar amount of a firm's derivatives position as of year-end 1995 for derivative users (scaled by total assets), and zero for non-users.

To test the third hypothesis, our dependent variable is the firm's "hedge ratio" (HR*), which reflects the firm's interest-risk exposure. We compute the hedge ratio as the ratio of the firm's notional amount of interest-rate derivatives to its total debt for derivatives users, and zero for non-users. We use total debt to proxy for a firm's total interest-rate-risk exposure. Thus,

Table 2. Industry Breakdown of Interest Rate, Currency, and Commodity Derivatives Use

Sample consists of 325 derivatives-using firms observed at year-end 1995. Two-digit SIC classification is used to classify firms by industry.

Industry	No. of Firms	Percentage Using Derivative Product Type		
		Interest-Rate	Currency	Commodity
Agriculture Products	2	50	50	100
Apparel and Other Finished Products	3	67	33	33
Building and General Construction	4	50	0	0
Business Services	17	41	18	0
Chemicals and Allied Products	39	55	64	27
Computer, Office Equipment	35	45	8	20
Communications	17	53	29	6
Durable Goods-Wholesale	6	50	0	17
Electronics and Electrical Equipment	31	39	45	19
Food	12	67	50	42
General Merchandise Stores	10	33	10	10
Health Services	6	33	17	0
Hotel	5	80	20	0
Lumber and Wood Products	2	50	0	50
Measurement Instrument, Photo Goods	13	43	52	19
Metal Mining	6	50	50	67
Oil and Gas Extraction	13	62	38	62
Paper and Allied Products	17	47	41	12
Petroleum Refining	18	44	44	39
Primary Metal Industry	13	62	15	23
Printing, Publishing, and Allied Products	12	42	25	17
Rubber and Plastic Products	9	44	67	22
Tobacco Products	3	33	67	33
Textile Mill Products	9	44	33	11
Transportation Equipment	17	59	41	12
Water Transportation	6	33	17	17

the hedge ratio indicates the extent of interest-rate derivatives use in proportion to total debt.

Also in the third test, as described in the previous section, we compute correlations (CORR) between a firm's cash flows and investment expenses. Investment expenses are defined as the sum of research and development costs, capital expenditures, and outlays on property, plant, and equipment.[5]

2. Growth Variables

To test each of the hypotheses, we repeat our analysis by using five different variables to proxy for a firm's investment or growth opportunities. The first two variables are normalized R&D expenses (RND) and the market-to-book ratio (MKT/BK). We define RND as the ratio of a firm's 1995 R&D expenses during the year measured relative to firm size (defined below), and MKT/BK as the market value of a firm's 1995 year-end equity divided by its book value.

As a potential improvement on using the MKT/BK variable, we also use Tobin's q, which we define as the market value of the firm divided by its replacement value as of year-end 1995. We calculate Tobin's q using the methodology in Lewellen and Badrinath (1997).[6]

[5]Fazzari, Hubbard, and Petersen (1988) use a firm's investment in plant and equipment to proxy for its investment expenses.

[6]Due to the intensive historic data requirements for implementing the Lewellen and Badrinath (1997) procedure, we reduce the numbers of user and non-user firms appearing in the full-sample tests involving Tobin'q to 153 and 100, respectively. Also, we did not conduct the restricted sample tests reported in Table 7 for Tobin's q because of insufficient sample size.

A fourth measure we use is a firm's price-to-earnings ratio (P/E), which we measure as the firm's 1995 year-end price divided by its 1995 earnings. Higher P/E ratios are typically associated with firms with higher growth prospects (see, for example, Brigham and Gapenski, 1994). Berkman and Bradbury (1996) use the earnings-price ratio in their study of derivatives use by New Zealand firms.[7]

Our final growth variable is a firm's market-adjusted cumulative abnormal return (CAR), which we base on all trading days of 1995 (see Brown and Warner, 1985). As discussed in Faught, Kale, and Rebello (1996), using CAR as a growth variable supports the view that a firm's stock price reflects the value of its future earnings both from assets in place and growth opportunities. Therefore, increases in a firm's growth opportunities should lead to an abnormal positive movement in the firm's stock price.[8]

3. Dummy Variable

We also use a dummy variable to test the second hypothesis. This helps delineate those firms for which we expect the underinvestment problem to be most important, e.g., those that have high growth opportunities and low cash.

To construct this dummy variable, we first measure cash stock as the ratio of cash and short-term investments to total assets as of year-end 1995. We define firms with cash stocks greater than the Compustat global mean as high-cash-stock firms. Otherwise, firms are considered to be low-cash-stock firms.

Similarly, for each of our five growth measures (with the exception of CAR), we define a firm to be a high- (low-) growth firm if the respective growth measure is higher (lower) than the Compustat global mean. For CAR, a firm is designated as high- (low-) growth if its CAR value is greater (less) than zero. Thus, we define the dummy variable (D_i) as having a value of one if the firm has both low cash and high growth opportunities concurrently, as indicated by growth measure i, and a value of zero otherwise. We use the dummy variable both independently and in conjunction with the various growth measures.

D. Control Variables

As mentioned earlier, in addition to alleviating underinvestment problems, a firm's hedging decision can be driven by several other considerations. For example, hedging might be used to reduce expected taxes, or costs associated with financial distress, for managerial wealth incentives, and for size considerations. We include several additional variables to control for these factors.

The tax argument for risk management, formalized by Smith and Stulz (1985), holds that in the presence of a convex tax schedule, firms can reduce expected taxes by using hedging instruments to reduce the variance of taxable earnings. A convex tax schedule can result from the progressivity of the corporate income tax code, and the presence of tax preference items, such as tax-loss carryforwards, foreign tax credits, and investment tax credits. Because most public companies have pre-tax income well above the progressive region, we use the availability of tax preference items, measured by the firm's book value of net operating loss carryforwards at the end of the fiscal year 1994 (scaled by firm size). The theory predicts that firms with greater net operating loss carryforwards (TAX) are more likely to use derivatives.

The financial-distress hypothesis suggests that to reduce the probability of financial distress, firms with greater leverage and financial exposure are more likely to hedge. We include two variables to proxy for financial distress. The first is the 1992-1994 three-year average of the interest coverage ratio (ICR). The lower a firm's coverage ratio, the greater its exposure to financial distress. The second measure is the 1992-1994 three-year average of the firm's debt-to-market-value ratio (DEBT). The theory predicts that firms with a higher ICR will use fewer derivatives, while firms with a higher DEBT will use more.

Managerial risk aversion can also influence a firm's hedging decision (see Smith and Stulz, 1985). A manager with undiversified personal wealth due to stock ownership in the firm or firm-specific human capital might engage in hedging. Thus, we use two variables to proxy for a manager's risk aversion, managerial shareholdings (STOCK) and stock-option holdings (OPTION). We measure information on both shareholdings and option holdings as of year-end 1994. We obtain our information from 1995 proxy statements. We compute STOCK as the log of the total market value of common shares beneficially owned by officers and directors as a group. We predict a positive relation between STOCK and the use of derivatives.

The second measure of a manager's risk aversion is OPTION which we define as the number of outstanding options exercisable within 60 days of the date reported in the proxy statement. The Smith and Stulz (1985) model predicts that managers with greater option holdings will prefer less hedging if the option payoff function is convex.

However, features of the stock options granted to the officers and directors question this prediction. The typical officer stock option has a term of 10 years,

[7]Because the P/E ratio is undefined for firms reporting negative earnings, we reduced the sample size for our full-sample tests using this measure to 293 users and 153 non-users, and for the restricted tests to 126 users and non-users, respectively.

[8]Lang, Poulsen, and Stulz (1995) use CARS to classify firms into poor versus good performers.

much longer than the term of traded options. Also, strike prices are usually set close to the price of the firm's stock at the date of the grant. Thus, even modest stock price performance will move the option deep in the money after a period of time.

Finally, as a matter of course, some firms cancel out-of-the-money options and replace them with new options with a lower strike price that is often equal to the current stock price (see Browning and Jereski, 1997). Thus, the convexity of the option payoffs can be minimal and the options can provide incentives similar to common shares. Therefore, a positive relation could exist between OPTION and derivatives use.

Although this paper focuses on the use of derivative contracts as a hedging vehicle, firms can and do pursue alternative activities that substitute for financial risk-management strategies. Previous empirical tests have used several different proxies for hedging alternatives. For example, Berkman and Bradbury (1996) and Nance, Smith, and Smithson (1993)use a firm's liquidity, dividend, convertible debt, and preferred-stock ratio to control for hedging substitutes. Mian (1996), Geczy, Minton, and Schrand (1995), and Tufano (1996) use a measure of a firm's liquidity and Wysocki (1996) uses a firm's dividend ratio. In the analysis below, we control for hedging alternatives by using the ratio of convertible debt to market value (CONV) and the ratio of preferred stock to market value (PREF), both measured as of year-end 1994. We expect to find a negative relation between both CONV and PREF and the use of derivatives.

Our last variable is firm size (SIZE), which we define as the log of the sum of book value of the firm's debt and preferred stock plus the market value of the firm's equity measured as of year-end 1994.[9] As discussed in Nance, Smith, and Smithson (1993), alternative arguments predict either a positive or negative relation between firm size and hedging activity. For example, the expected costs of financial distress are not constant across firms, since bankruptcy costs are inversely proportional to size (Warner, 1977). Thus, smaller firms have a greater incentive to hedge. Size is also related to economies of scale in establishing and maintaining the expertise to conduct a hedging program. This suggests that larger firms are likely to hedge more. Typically, most empirical investigations find a positive association between a firm's size and derivatives use.[10]

III. Empirical Results

This section gives the results of the tests of our three hypotheses, using both univariate and multivariate techniques.

A. Univariate Analysis

We first report the statistical comparisons of the various financial measures described above for both users and non-users of derivatives. We discuss the results for both the entire sample and the sample of users of interest-rate-only derivatives.

1. Control Variables

As mentioned earlier, previous studies have offered theories that relate a firm's hedging decision to factors such as reducing underinvestment problems, expected taxes, the expected costs associated with financial distress, and to managerial wealth incentives. The tax argument suggests that derivatives users should have greater tax loss carryforwards (TAX) than non-users. As shown in Table 3, the variable TAX for users is significantly greater at the 0.05 level, which supports this supposition. Similarly, the financial distress theory suggests that users should have a higher debt ratio. The DEBT statistic for users is significantly greater at the 0.01 level. However, we find little difference in interest coverage ratios (ICR). The two managerial risk-aversion variables, STOCK and OPTION, are opposite in sign to the theoretical predictions, although only the shareholdings variable is significant. Non-users show that officers and directors beneficially own more shares and their option holdings are less. Also, the results for CONV and PREF are contrary to predictions, because users tend to use more convertible debt and preferred stock. However, only PREF is significant. Finally, SIZE for non-users appears slightly larger than for users, but the difference is insignificant.

For the sample of interest-rate-only users of derivatives and the matched non-users, the results are consistent with those reported above for the entire sample, but show several differences.[11] The difference for TAX has the predicted sign (users have greater tax-loss carryforwards) but the t-statistic of 1.58 is no longer significant. Consistent with our prediction, the interest coverage ratio (ICR) of users is significantly less than that of non-users.

As before, managerial shareholdings (STOCK) for non-users are greater than those of users, but the difference is no longer significant. The results for CONV and PREF do not indicate any statistically significant differences. The variable SIZE is significantly greater for non-users at the 0.01 level.

2. Growth Variables

According to theory, firms that have greater growth

[9]The log is not taken when firm size is used as a scaling variable, e.g., for RND and TAX.

[10]See Geczy, Minton, and Schrand (1995), Mian (1996), Nance, Smith, and Smithson (1993), and Wysocki (1996). However, Tufano (1996) finds an indeterminate relation.

[11]A table providing the full results is available from the authors upon request.

Table 3. Comparisons of Financial Characteristics of Derivatives Users and Non-Users

This table reports summary statistics for financial characteristics of firms disclosing the use and non-use of derivatives as of fiscal year-end 1995. The t-statistic tests are for the difference of means between users and non-users. In the table, TAX is the ratio of the book value of net operating loss carryforwards to total assets; DEBT is the three-year average of the firm's debt-to-market-value ratio; ICR is the three-year average of the interest coverage ratio; STOCK is the log of the total market value of common shares beneficially owned by officers and directors; OPTION is the number of outstanding stock options exercisable within 60 days; CONV is the ratio of convertible debt to market value; PREF is the ratio of preferred stock to market value; SIZE is the log of the sum of the book value of the firm's debt and preferred stock plus the market value of common equity; CAR is the market-adjusted cumulative abnormal return for 1995; RND is the ratio of a firm's R&D expenditures to the firm's market value; Q is Tobin's q; MKT/BK is the ratio of a stock's market price to its book value; and P/E is the ratio of a stock's market price to earnings per share. The number of users and non-users in the sample is 325 and 161, respectively. Results for P/E and Q are based on a sample of 293 users and 153 non-users, and 203 users and 100 non-users of derivatives, respectively.

Independent Variables	Users Mean (Std. Dev.)	Non-Users Mean (Std. Dev.)	t-Statistic
TAX	0.022 (0.064)	0.010 (0.046)	2.14**
DEBT	0.169 (0.134)	0.129 (0.124)	3.24***
ICR	52.312 (660.321)	50.551 (165.006)	0.05
STOCK	7.465 (0.734)	7.666 (0.839)	-2.56**
OPTION	9.04E+5 (1.25E+6)	7.81E+5 (1.21E+6)	1.03
CONV	0.009 (0.030)	0.006 (0.023)	1.12
PREF	0.005 (0.024)	0.002 (0.013)	1.88*
SIZE	3.255 (0.728)	3.290 (0.508)	-0.60
CAR	0.184 (0.370)	0.115 (0.311)	2.06**
RND	0.022 (0.038)	0.016 (0.035)	1.87**
Q	2.138 (1.041)	2.120 (1.913)	0.10
MKT/BK	3.001 (2.876)	3.121 (2.621)	-0.45
P/E	24.972 (73.899)	20.145 (29.125)	0.78

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

or investment opportunities should have a greater underinvestment problem. This suggests that the various growth measures for the sample of user firms should be greater than those of the non-user sample.

For results for the entire sample reported in Table 3, the difference of means is positive for four of the five growth measures, and significant for two of them at the 0.05 level. The significant measures are

CAR and RND. However, Q and P/E are insignificant and MKT/BK is insignificantly negative. Similar findings were obtained for the sample of interest-rate-only users of derivatives.

The third hypothesis states that firms with a higher correlation between cash flows and investment expenses have less incentive to hedge, because they have fewer (greater) attractive investment opportunities in states with lower (higher) cash realizations. Support for this hypothesis appears in our final variable of interest, CORR. The results from our restricted sample of interest-rate-only users of derivatives (see footnote 11) indicate that non-users of derivatives have higher levels of correlation between cash flow and investment expenses than do users of derivatives.

B. Multivariate Analysis

Next, we provide the results from alternative Tobit estimation procedures.

1. Tests of Hypothesis 1: Derivatives Use and Investment Opportunities

Hypothesis 1 states that firms with greater investment or growth opportunities will make greater use of derivatives. Recall that for users of derivatives, Y* equals a firm's notional dollar amount of derivatives holdings scaled by total assets, and is equal to zero for non-users. We estimate the following relation using the Tobit estimation procedure, which relates a firm's derivatives use to the set of explanatory control variables plus a proxy for a firm's investment opportunities ($GROWTH_i$):

$$Y^* = \beta_0 + \beta_1 TAX + \beta_2 DEBT + \beta_3 ICR + \beta_4 STOCK + \beta_5 OPTION + \beta_6 CONV + \beta_7 PREF + \beta_8 SIZE + \beta_9 GROWTH_i \quad i = 1, \ldots, 5 \qquad (1)$$

We repeat the estimation of the above model for each of the five alternative growth measures, CAR, RND, Q, MKT/BK and P/E.

Table 4 presents the results from this model. For each estimation of the model, only two of the control variables are significant. The variable DEBT is positive and significant at the 0.01 level, which supports the argument that more highly leveraged firms make greater use of derivatives, since they face higher expected costs of financial distress. The coefficient of OPTION, the number of stock options held by officers and directors, is also significant and positive. This finding is counter to both the negative prediction of Smith and Stulz (1985) and to the empirical findings of Tufano (1996) for the gold-mining industry. However, as discussed earlier, certain features of stock options granted to corporate managers (i.e., long-term, initial at-the-money strike price, and the tendency to replace out-of-the-money options) tend to make the expected payoff of these options similar to the expected payoff from common stocks. The remaining control variables are all insignificant.

More importantly, each of the five growth proxies is positive and significant. CAR, RND, Q, and MKT/BK are significant at the 0.05 level and P/E is significant at the 0.01 level. These findings support Hypothesis 1.

2. Tests of Hypothesis 2: Interaction Between Cash and Investment Opportunities

Hypothesis 2 states that firms with enhanced investment opportunities concurrently with low levels of cash stocks will make greater use of derivatives than do similar firms with higher cash stocks. We use two approaches to analyze this hypothesis. First, we restrict our attention to only those firms that have high growth opportunities (i.e., higher than average). We then split this sample of firms into two groups. The first group comprises those firms with high growth opportunities and low cash stocks, and the second group contains high-growth firms with high cash stocks. Since we expect the underinvestment problem to be most important for high-growth firms with low cash, we expect their level of derivatives use to be greater. Thus, we compare the mean derivatives use of the two groups.

Table 5 reports evidence that supports the second hypothesis. The mean difference in derivatives use between the two groups of firms is positive for each of the five growth measures. For three of the measures, CAR, RND, and P/E, the differences are significant at the 0.10, 0.10, and 0.05 levels, respectively.

We also test the second hypothesis by using the full sample of both derivatives users and non-users. We respecify the Tobit model to include dummy variables for capturing potential interactive effects among derivatives use, cash, and growth opportunities.

$$Y^* = \beta_0 + \beta_1 TAX + \beta_2 DEBT + \beta_3 ICR + \beta_4 STOCK + \beta_5 OPTION + \beta_6 CONV + \beta_7 PREF + \beta_8 SIZE + \beta_9 GROWTH_i + \beta_{10} D_i + \beta_{11} D_i * GROWTH_i \quad i = 1, \ldots, 5 \qquad (2)$$

Recall that D_i is a dummy variable with a value of one for firms simultaneously having low cash stock (i.e., lower than average) and high growth opportunities (i.e., higher than average), and zero otherwise. According to the Froot, Scharfstein, and Stein (1993), for a firm with significant growth opportunities, the underinvestment problem becomes most important when it has low cash availability. Equation (2) targets this condition by allowing for both an intercept and slope change in the relation between

Table 4. Tobit Model Estimates of the Determinants of Corporate Derivatives Use

The table presents results from a Tobit model, censored at 0, that relates the likelihood and the extent of corporate use of derivatives to a set of financial and managerial variables and five alternative growth proxies. The sample consists of 325 users and 161 non-users of derivatives as of fiscal year-end 1995. Results for the model using P/E and Tobin's q are based on a sample of 293 users and 153 non-users, and 203 users and 100 non-users of derivatives, respectively. The dependent variable is the notional value of outstanding interest-rate, foreign currency, and commodity derivatives scaled by total assets. In the table, TAX is the ratio of the book value of net operating loss carryforwards to total assets; DEBT is the three-year average of the firm's debt-to-market-value ratio; ICR is the three-year average of the interest coverage ratio; STOCK is the log of the total market value of common shares beneficially owned by officers and directors; OPTION is the number of outstanding stock options exercisable within 60 days; CONV is the ratio of convertible debt to market value; PREF is the ratio of preferred stock to market value; SIZE is the log of the sum of the book value of the firm's debt and preferred stock plus the market value of common equity; CAR is the market-adjusted cumulative abnormal return for 1995; RND is the ratio of a firm's R&D expenditures to the firm's market value; Q is Tobin's q; MKT/BK is the ratio of a stock's market price to its book value; and P/E is the ratio of a stock's market price to earnings per share. Standard errors are provided in parentheses.

Independent Variables	(1)	(2)	(3)	(4)	(5)
Intercept	0.134	0.101	0.154	0.157	0.125
	(0.101)	(0.103)	(0.121)	(0.101)	(0.100)
TAX	-0.003	-0.003	0.382	-0.003	-0.005
	(0.002)	(0.002)	(0.398)	(0.002)	(0.002)
DEBT	0.245	0.309	0.342	0.286	0.257
	(0.080)***	(0.087)***	(0.096)***	(0.082)***	(0.079)***
ICR	-7.51E-6	-9.22E-6	-6.01E-6	-8.27E-6	-7.26E-6
	(1.5E-5)	(1.6E-5)	(1.6E-5)	(1.5E-5)	(1.6E-5)
STOCK	-0.018	-0.013	-0.024	-0.020	-0.015
	(0.013)	(0.014)	(0.015)	(0.013)	(0.013)
OPTION	1.46E-8	1.39E-8	2.07E-8	1.34E-8	1.51E-8
	(7.6E-9)*	(7.6E-9)*	(8.9E-9)**	(7.6E-9)*	(7.5E-9)**
CONV	-0.215	-0.339	-0.578	-0.307	0.340
	(0.339)	(0.340)	(0.434)	(0.336)	(0.334)
PREF	-0.011	-0.049	-0.027	-0.123	-0.175
	(0.423)	(0.422)	(0.470)	(0.419)	(0.415)
SIZE	-0.003	-0.007	-0.008	-0.012	-0.009
	(0.015)	(0.015)	(0.019)	(0.015)	(0.015)
CAR	0.060				
	(0.027)**				
RND		0.535			
		(0.279)**			
Q			0.016		
			(0.007)**		
MKT/BK				0.008	
				(0.003)**	
P/E					7.30E-4
					(2.2E-4)***

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

Table 5. Comparisons of Derivative Use: High-Growth, Low-Cash Firms Compared to High-Growth, High-Cash Firms

This table reports summary statistics for the use of derivatives by firms classified as being either high-growth, low-cash firms or high-growth, high-cash firms. Derivative use is measured as the total notional value of outstanding interest-rate, foreign currency, and commodity derivatives scaled by total assets. The t-statistic tests are for the difference of means between the two sets of firms. In the table, CAR is the market-adjusted cumulative abnormal return for 1995; RND is the ratio of a firm's R&D expenditures to the firm's market value; Q is Tobin's q; MKT/BK is the ratio of a stock's market price to its book value; and P/E is the ratio of the stock's market price to earnings per share. Firms with cash stock greater (lower) than the Compustat global mean are classified as high (low) cash firms. Firms with a growth measure greater (less) than the global mean of all firms with available information included in Compustat (or greater (less) than zero in the case of CAR) are classified as high (low) growth firms. A firm's cash stock is measured by the ratio of cash and short-term investments to total assets.

Growth Measure	Low-Cash Notional Value/Total Assets (Standard Deviation) (N = Number of Users)	High-Cash Notional Value/Total Assets (Standard Deviation) (N = Number of Users)	t-Statistic
CAR	0.147 (0.181) (N = 78)	0.121 (0.108) (N = 69)	1.67*
RND	0.149 (0.151) (N = 86)	0.113 (0.110) (N = 78)	1.65*
Q	0.163 (0.154) (N = 63)	0.143 (0.130) (N = 52)	0.68
MKT/BK	0.159 (0.200) (N = 89)	0.130 (0.124) (N = 64)	1.07
P/E	0.193 (0.193) (N = 78)	0.091 (0.094) (N = 74)	2.30**

**Significant at the 0.05 level.
*Significant at the 0.10 level.

derivatives use and growth, conditioned on the firm having both low-cash and high-growth opportunities.[12] We use the intercept dummy (D_i) to examine the difference in the level of derivatives use between high-growth firms with low levels of cash and other firms. The slope term allows us to test the relative importance of growth opportunities for firms with low cash levels.

Table 6 gives the Tobit results for Equation (2). However, in contrast to the results provided in Table 4, none of the coefficients on the various growth measures are significant.

However, evidence that supports the role of cash as a determinant of derivatives use is evident in the coefficients pertaining to the various dummy variables. Each of the five estimates on the intercept dummy (D_i) is positive. Two of the measures, RND and P/E, are significant at the 0.01 and 0.10 levels, respectively. This suggests that there is a positive difference in the level of derivatives use between high-growth firms having low cash stocks and other firms. In addition, for the other three growth variables CAR, Q, and MKT/BK, the slope estimates on the term (D_i*GROWTH$_i$) are positive and significant at the 0.10, 0.01, and 0.01 levels, respectively. This finding suggests that for firms classified as having low-cash availability and high-growth opportunities, there is a greater level of sensitivity between derivatives use and growth opportunities.

The results from these two tests support the second hypothesis. Our results are also consistent with, and add insight to, those of Gezcy, Minton, and Schrand (1995) and Berkman and Bradbury (1996), who report a negative association between a firm's decision to use derivatives and short-term liquidity.

[12]Opler and Titman (1993) use dummy variables in an analogous manner to identify firms that have, simultaneously, low Tobin's q and high cash flow. Lang, Stulz, and Walkling (1991) use a similar approach.

Table 6. Tobit Model Estimates of the Interactive Influence of Cash and Investment Opportunities on Corporate Derivatives Use

The table presents results from a Tobit model, censored at 0, that relates the likelihood and the extent of corporate use of derivatives to a set of financial and managerial variables and five alternative growth proxies. The common sample consists of 325 users and 161 non-users of derivatives. Results for estimations using P/E and Tobin's q are based on the sample of 293 users and 153 non-users, and 203 users and 100 non-users of derivatives, respectively. The dependent variable is the notional value of outstanding interest-rate, foreign currency, and commodity derivatives scaled by total assets. In the table, TAX is the ratio of the book value of net operating loss carryforwards to total assets; DEBT is the three-year average of the firm's debt-to-market value ratio; ICR is the three-year average of the interest coverage ratio; STOCK is the log of the total market value of common shares beneficially owned by officers and directors; OPTION is the number of outstanding stock options exercisable within 60 days; CONV is the ratio of convertible debt to market value; PREF is the ratio of preferred stock to market value; SIZE is the log of the sum of the book value of the firm's debt and preferred stock plus the market value of common equity; CAR is the market-adjusted cumulative abnormal return for 1995; RND is the ratio of a firm's R&D expenditures to the firm's market value; Q is Tobin's q; MKT/BK is the ratio of a stock's market price to its book value; P/E is the ratio of a stock's market price to earnings per share; D_i is a dummy variable with a value of 1 for firms with cash stock lower than the average and a growth measure (i.e., RND, Q, MKT/BK, and P/E) greater than the global mean of all firms with available information included in Compustat (or greater than 0 in the case of CAR), and 0 otherwise. Standard errors are provided in parentheses.

Independent Variables	(1)	(2)	(3)	(4)	(5)
Intercept	0.123	0.049	0.176	0.177	0.128
	(0.101)	(0.103)	(0.102)	(0.100)	(0.099)
TAX	-0.003	-0.003	-0.003	-0.003	-0.005
	(0.002)	(0.002)	(0.002)	(0.002)	(0.006)
DEBT	0.248	0.350	0.251	0.255	0.239
	(0.080)***	(0.087)***	(0.088)***	(0.083)***	(0.080)***
ICR	-8.15E-6	-9.19E-6	-9.63E-6	-6.45E-6	-1.06E-5
	(1.6E-5)	(1.5E-5)	(1.6E-5)	(1.6E-5)	(1.6E-5)
STOCK	-0.018	-0.006	-0.017	-0.016	-0.016
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
OPTION	1.29E-8	1.33E-8	1.35E-8	1.20E-8	1.47E-8
	(7.6E-9)**	(7.5E-9)*	(7.6E-9)*	(7.5E-9)*	(7.4E-9)**
CONV	-0.208	-0.366	-0.280	-0.308	-0.393
	(0.338)	(0.334)	(0.338)	(0.332)	(0.332)
PREF	-0.024	0.043	-0.088	-0.197	-0.293
	(0.421)	(0.416)	(0.420)	(0.416)	(0.414)
SIZE	-0.001	-0.018	-0.009	-0.016	-0.006
	(0.016)	(0.015)	(0.015)	(0.017)	(0.015)
CAR	0.021				
	(0.041)				
RND		0.182			
		(0.433)			
Q			0.021		
			(0.015)		
MKT/BK				-0.014	
				(0.009)	
P/E					-1.87E-4
					(6.6E-4)
D1	0.024	0.101	0.070	0.020	0.045
	(0.040)	(0.026)***	(0.049)	(0.034)	(0.020)*

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

Table 6. Tobit Model Estimates of the Interactive Influence of Cash and Investment Opportunities on Corporate Derivatives Use (*Continued*)

Independent Variables	(1)	(2)	(3)	(4)	(5)
D1*CAR	0.087 (0.043)*				
D1*RND		0.253 (0.568)			
D1*Q			0.052 (0.021)***		
D1*MKT/BK				0.026 (0.010)***	
D1*P/E					8.10E-4 (7.1E-4)

***Significant at the 0.01 level.
*Significant at the 0.10 level.

3. Tests of Hypothesis 3: Correlation Effects Between a Firm's Cash Flows and Investment Opportunities

The third hypothesis states that firms with greater correlation between cash flows and investment expenses will use derivatives less. As discussed earlier, in general, current accounting reporting practices do not allow the accurate measurement of pre-risk-management cash flows needed in the computation of the correlation. Thus, our tests are restricted to firms that use only interest-rate derivatives, and to the matched sample of non-users. Nevertheless, the basic intuition of the third hypothesis should still apply to the restricted sample.

We test the following model, which relates HR* (the ratio of the firm's notional amount of interest-rate derivatives to its total debt) to CORR and the other control variables.[13] Again, we use the Tobit-estimation procedure.

$$HR^* = \beta_0 + \beta_1 TAX + \beta_2 ICR + \beta_3 STOCK + \beta_4 OPTION + \beta_5 CONV + \beta_6 PREF + \beta_7 SIZE + \beta_8 GROWTH + \beta_9 CORR \quad i = 1, ..., 4 \qquad (3)$$

The results are reported in Table 7. The major variable of interest, CORR, the correlation between a firm's cash flow and investment expenses, is negative, as predicted, and statistically significant in each of the model estimations that use the four growth measures. The results indicate that a firm's hedge ratio is inversely related to the correlation between its cash flows and investment expenditures.[14]

Another interesting result in Table 7 is that SIZE is negative and significant at the 0.01 level. This result suggests that larger firms tend to hedge a lower fraction of their interest-rate risk exposure and appears to contradict the economies-of-scale explanation that suggests a positive association between size and derivatives use. Rather, this result supports the hypothesis that larger firms benefit less from hedging because they have lower levels of information asymmetry (see DeMarzo and Duffie, 1995) or face lower expected costs of financial distress due to lower proportional bankruptcy costs (see Warner, 1977).

IV. Summary

Our paper extends previous findings on determinants of corporate derivatives use by examining more closely the underinvestment hypothesis modeled by Froot, Scharfstein, and Stein (1993). Specifically, we study the interaction effects among a firm's investment opportunities, cash stock, and internally generated funds to more clearly distinguish the role of the underinvestment hypothesis in the determination of corporate hedging policy.

We find several interesting results that support the role of potential underinvestment problems. First, we find consistent evidence that associates various proxies for a firm's investment opportunity set with

[13]Titman (1992) provides an alternative explanation, based on asymmetric information arguments, as to why firms use interest-rate derivatives. Rather than issue long-term, fixed-rate debt, firms that expect their credit quality to improve can borrow short-term and use swaps to hedge their interest-rate risk, thus preserving the opportunity of borrowing under more favorable terms in the future. We do not investigate this hypothesis.

[14]We repeated these tests after including each firm's leverage ratio (e.g., debt to total assets). This was to determine whether the findings are indeed related to alleviating the underinvestment problems and not the costs of financial distress. In results not reported, CORR remained negative and significant and the leverage variable was insignificant.

Table 7. Tobit Model Estimates of the Influence of the Correlation Between a Firm's Cash Flows and Investment Expenses on Derivatives Use

The table presents results from a Tobit model, censored at 0, that relates the likelihood and the extent of corporate use of interest-rate derivatives to financial and managerial variables, a correlation variable, and four alternative growth proxies. The sample consists of 137 users and non-users of derivatives as of the end of fiscal year 1995. (Results for the P/E are based on the sample of 126 users and non-users of derivatives.) The dependent variable is the ratio of the notional value of outstanding interest-rate derivatives scaled by a firm's total debt (HR). In the table, TAX is the ratio of the book value of net operating loss carryforwards to total assets; ICR is the three-year average of the interest coverage ratio; STOCK is the log of the total market value of common shares beneficially owned by officers and directors; OPTION is the number of outstanding stock options exercisable within 60 days; CONV is the ratio of convertible debt to market value; PREF is the ratio of preferred stock to market value; SIZE is the log of the sum of the book value of the firm's debt and preferred stock plus the market value of common equity; CAR is the market-adjusted cumulative abnormal returns for 1995; RND is the ratio of a firm's R&D expenditures to the firm's market value; MKT/BK is the ratio of a stock's market price to its book value; P/E is the ratio of a stock's market price to earnings per share; and CORR is the correlation between the firm's cash flows and investment expenditures. Standard errors are provided in parentheses.

Independent Variables	(1)	(2)	(3)	(4)
Intercept	6.110	5.894	6.011	5.874
	(2.137)	(2.153)	(2.158)	(2.173)
TAX	-0.260	0.316	0.362	0.413
	(2.976)	(2.984)	(3.006)	(3.009)
ICR	-0.011	-0.011	-0.010	-0.010
	(0.006)	(0.006)	(0.006)	(0.006)
STOCK	0.083	0.123	0.129	0.115
	(0.298)	(0.299)	(0.299)	(0.301)
OPTION	-4.45E-8	-1.92E-8	-3.49E-9	-1.73E-8
	(1.99E-7)	(2.02E-7)	(2.02E-7)	(2.01E-7)
CONV	-4.141	-0.593	-2.659	-3.515
	(6.550)	(0.297)	(6.745)	(6.625)
PREF	1.336	1.979	1.377	1.149
	(11.033)	(11.065)	(11.187)	(11.168)
SIZE	-2.499	-2.639	-2.656	-2.632
	(0.520)***	(0.518)***	(0.516)***	(0.529)***
CAR	1.153			
	(0.725)			
RND		5.320		
		(10.016)		
MKT/BK			0.049	
			(0.073)	
P/E				0.003
				(0.003)
CORR	-0.630	-0.593	-0.609	-0.569
	(0.296)**	(0.297)**	(0.300)**	(0.301)*

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

derivatives use. These various proxies include a measure of the firm's CARs, research and development expenses, Tobin's q, the market-to-book-value ratio, and the price-earnings ratio.

Our second main finding is that when we examine the interaction effects between a firm's cash stock and its investment opportunities, we find that firms with enhanced investment opportunity sets use derivatives

more when they also have relatively lower levels of cash.

Our third main finding indicates that the correlation between internally generated cash flows and investment outlays also influences a firm's derivatives use. We find a negative relation between a firm's derivatives use and this correlation. This supports the argument that a higher correlation acts to alleviate a firm's underinvestment problem because the firm is, in some sense, naturally hedged.

These findings support the hypothesis that firms' derivatives use is driven in part by the need to avoid possible underinvestment problems. Our results show that firms can and do use derivatives as one strategy to maximize shareholder value. ■

References

Berkman, H. and M.E. Bradbury, 1996, "Empirical Evidence on the Corporate Use of Derivatives," *Financial Management* (Summer), 5-13.

Berkman, H., M.E. Bradbury, and S. Magan, 1997, "An International Comparison of Derivatives Use," *Financial Management* (Winter), 69-73.

Bodnar, G.M., G.S. Hayt, and R.C. Marston, 1996, "1995 Wharton Survey of Derivatives Usage by U.S. Non-Financial Firms," *Financial Management* (Winter), 113-133.

Brigham, E.F. and L.C. Gapenski, 1994, *Financial Management: Theory and Practice*, 7th ed., Chicago, IL, Dryden Press.

Brown, S.J. and J.B. Warner, 1985, "Using Daily Stock Returns: The Case of Event Studies," *Journal of Financial Economics* (March), 3-31.

Browning, E.S. and L. Jereski, 1997, "In the Money: Firms with Sagging Stocks Set New 'Repricings' of Executive Options," *Wall Street Journal* (June 11), C1-C2.

DeMarzo, P.M. and D. Duffie, 1995, "Corporate Incentives for Hedging and Hedge Accounting," *Review of Financial Studies* (Fall), 743-771.

Dolde, W., 1995, "Hedging, Leverage, and Primitive Risk," *Journal of Financial Engineering* (June), 187-216.

Faught, J.G., J.R. Kale, and M.C. Rebello, 1996, "On the Relative Efficacy of Tobin's q and Other Firm Quality Measures," Georgia State University Working Paper.

Fazzari, S.M., G.R. Hubbard, and B.C. Petersen, 1988, "Financing Constraints and Corporate Investment," *Brookings Papers on Economic Activity* (No. 1), 141-206.

Froot, K.A., D.S. Scharfstein, and J.C. Stein, 1993, "Risk Management: Coordinating Corporate Investment and Financing Policies," *Journal of Finance* (December), 1629-1658.

Geczy, C., B.A. Minton, and C. Schrand, 1995, "Why Firms Hedge: Distinguishing Among Existing Theories," Ohio State University Working Paper.

Lang, L.H.P., A. Poulsen, and R.M. Stulz, 1995, "Asset Sales, Firm Performance, and the Agency Costs of Managerial Discretion," *Journal of Financial Economics* (January), 3-38.

Lang, L.H.P., R.M. Stulz, and R.A. Walkling, 1991, "The Case of Bidder Returns," *Journal of Financial Economics* (October), 315-335.

Lewellen, W.G. and S.G. Badrinath, 1997, "On the Measurement of Tobin's q," *Journal of Financial Economics* (April), 77-122.

Lewent, J. and A. J. Kearney, 1990, "Identifying, Measuring and Hedging Currency Risk at Merck," *Journal of Applied Corporate Finance* (Winter), 19-28.

Li, H., 1996, "Corporate Use of Interest Rate Swaps: Empirical Evidence," Yale University Working Paper.

Ljungqvist, M., 1994, "Asymmetric Information: A Rationale for Corporate Speculation," *Journal of Financial Intermediation* (March), 188-203.

Mian, S.L., 1996, "Evidence on Corporate Hedging Policy," *Journal of Financial and Quantitative Analysis* (September), 419-439.

Modigliani, F. and M.H. Miller, 1958, "The Cost of Capital, Corporation Finance, and the Theory of Investment," *American Economic Review* (June), 261-297.

Nance, D.R., C.W. Smith, and C.W. Smithson, 1993, "On the Determinants of Corporate Hedging," *Journal of Finance* (March), 267-284.

Opler, T. and S. Titman, 1993, "The Determinants of Leveraged Buyout Activity: Free Cash Flow vs. Financial Distress Costs," *Journal of Finance* (December), 1985-1999.

Petersen, M.A. and S.R. Thiagarajan, 1997, "Risk Management and Hedging," J.L. Kellogg Graduate School of Management, Northwestern University Working Paper.

Smith, C.W., C.W. Smithson, and S.D. Wilford, 1990, *Managing Financial Risk*, New York, NY, Harper Business, 355-378.

Smith, C.W. and R.M. Stulz, 1985, "The Determinants of Firms' Hedging Policies," *Journal of Financial and Quantitative Analysis* (December), 391-405.

Smithson, C.W., 1997, *The State of Play in Financial Risk Management*, New York, NY, CIBC Wood Gundy School of Financial Products.

Titman, S., 1992, "Interest Rate Swaps and Corporate Financing Choices," *Journal of Finance* (September), 1503-1516.

Titman, S. and R. Wessels, 1988, "The Determinants of Capital Structure Choice," *Journal of Finance* (March), 1-19.

Tufano, P., 1996, "Who Manages Risk? An Empirical Examination of Risk Management Practices in the Gold-Mining Industry," *Journal of Finance* (September), 1097-1137.

Tufano, P., 1998, "Agency Costs of Corporate Risk Management," *Financial Management* (Spring), 67-77.

Warner, J.B., 1977, "Bankruptcy Costs: Some Evidence," *Journal of Finance* (May), 337-348.

Wysocki, P.D., 1996, "Managerial Motives and Corporate Use of Derivatives: Some Evidence," Simon School of Business, University of Rochester Working Paper.